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The Ins and Outs of Iranian Industrial Resiliency Under Sanctions

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Abstract

This paper draws on export data from four of Iran's key trade partners—the European Union, China, the United Arab Emirates, and Turkey—to examine the robust and positive correlations between the export of parts and machinery to Iran and Iran's industrial productivity, as measured by the Total Productivity Index published by the Central Bank of Iran for the period between 2001 and 2018. It may seem intuitive that the productivity of Iranian manufacturers depends on the ability of companies to source key parts and machinery. However, the imposition of sanctions on Iran is shown to have temporarily decoupled the relationship between European industrial exports to Iran and Iranian industrial productivity—industrial productivity remained stable even as European exports fell. An analysis of trade data for the other three trade partners included in this study quantitatively substantiates reports that in order to sustain productivity, Iran engaged in a processes than can be collectively described as "import reflection"—substituting European intermediate inputs with Chinese inputs while also circumventing sanctions pressures on trade by sourcing European inputs via re-export from the UAE and Turkey. These processes were fundamental to Iran's economic resiliency in the face of multilateral sanctions and will likely play a central role in Iran's defense of its industrialized economy and particularly its non-oil exports as the administration of U.S. President Donald Trump pursues a new unilateral campaign of "maximum pressure" sanctions.

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1. Introduction

Between 2008 and 2016—a period that corresponds to the launch of the multilateral sanctions campaign against Iran and the implementation of sanctions relief under the Joint Comprehensive Plan of Action nuclear deal—Iran experienced only three years of economic contraction—2012, 2013, and 2015. The only sizeable contraction occurred in 2012 when Iran's economy shank by about 7.5% as the multilateral sanctions campaign was expanded to include stringent financial sanctions that significantly restricted correspondent banking channels between Iranian and global banks, particularly those in Europe.

Why such an expansive sanctions campaign did not lead to a prolonged recession in Iran remains one of the great understudied questions of international political economy. In broad terms, we know that Iran responded to the economic pressure by seeking to significantly increase its non-oil exports, taking advantage of the devaluation of the rial triggered in part by sanctions. In the period from 2008 to 2016, the country's non-oil exports rose from $16 billion to $26 billion dollars. While Iran's non-oil exports have enjoyed uninterrupted growth since the mid-1990s, the rate of growth actually increased under sanctions as the Iranian government encouraged enterprises to seek opportunities beyond the country's borders, particularly in markets such as Iraq, Turkey, and Afghanistan. The foreign exchange earnings related to this trade helped keep Iran's economy turning even as sanctions both reduced the volume of Iran's oil exports and restricted Iran's ability to repatriate its oil revenue.

Growth in non-oil exports may help explain how Iran was able to withstand sanctions pressures, but it is not immediately clear how non-oil exports were able to grow given the restrictions sanctions imposed on Iran's economy. While Iran's non-exports are primarily destined for regional markets, where the impact of extraterritorial sanctions is less profound, the goods that constitute Iran's non-oil exports are produced by industrial and agriculture sectors that are far from self-sufficient. The export of petrochemical products, steel products, consumer durables, pharmaceutical products, and food products depends on Iran's ability to reliable import manufacturing inputs and industrial parts and machinery. In this way, the strategy to expand non-oil exports remains vulnerable to sanctions pressures. Had sanctions significantly interrupted supply chains and thereby reduced Iran's industrial productivity, the country would have necessarily struggled to expand its non-oil exports. In this way, the observed expansion of non-oil exports from 2008 to 2015 suggests that sanctions were ineffective at substantially

constraining the ability of Iranian industries to import key intermediate inputs and thereby maintain industrial productivity.

In November 2018, the Trump administration launched a new unilateral sanctions campaign, having formally withdrawn from the Joint Comprehensive Plan of Action nuclear deal in May of that year.[1] Trump administration officials have vowed to wage an "economic war" on Iran, using sanctions to exert "maximum pressure" on Iran's economy. Most notably, the U.S. has sought to cut Iran's oil exports "to zero" by eliminating the Significant Reduction Exemption (SRE) sanctions waivers that permitted several of Iran's top oil customers to continue their imports of Iranian oil on the condition that revenues were paid into tightly controlled escrow accounts.[2] While China has sustained some imports of Iranian oil in direct defiance of U.S. sanctions, 2019 will be a landmark year in which non-oil export revenue exceeds oil export revenue for the first time in Iran's modern history.

Iran once again faces the challenge of defending its economy from a sanctions campaign, although in this instance the campaign is unilateral in nature—neither the EU nor UN has sought to join with the U.S. effort so far. The remaining parties to the nuclear deal—France, Germany, the United Kingdom, Russia, and China—have taken steps to encourage Iran to remain in compliance with the agreement, principally by exploring ways to help protect Iran's economy from the brunt of U.S. sanctions. But they have achieved little to date. With sanctions impacts compounded by a currency crisis that began in January of 2018, weakening the rial by around 70% before recovering some strength 2019, Iran's economy is predicted to contract by 9% this year.[3]

For Iran's policymakers and economic actors, the question is whether the 9% contraction represents the nadir of a v-shaped recovery, as was the case with the sharp contraction in 2012,

or whether a more sustained recession should be expected. The answer to this question will be determined by the trajectory of Iran's non-oil exports, and by extension, the degree to which Iran is able to sustain its industrial productivity in the face of the new sanctions campaign. There are some early indications that Iran's economy may once again shrug-off sanctions pressures after the initial sharp contraction. The purchasing manager's index (PMI) for the first six months of 2019 points to growing optimism about industrial productivity and some stabilization after the currency-related disruptions of 2018. Notably, Iran's purchasing managers are increasingly confident in the reliability of their supply of intermediate inputs as they approach the one year anniversary of the reimposition of U.S. secondary sanctions.[4]

In order to better understand the resiliency of the Iranian economy under sanctions, and particularly the resiliency of Iran's industrial base, this paper examines the relationship between the availability of intermediate inputs to Iran's total industrial output. Whether Iran can sustain its industrial output under sanctions depends in large part on the ability of industrial firms to source key intermediate inputs, particularly the parts, equipment, and machinery necessary to keep assembly lines running. Our understanding of Iran's industrial resiliency should therefore be informed by the degree to which Iran can be shown to have sustained the supply of inputs under sanctions, and thereby sustained its total industrial output.

2. Literature Review

There is a growing body of research that has sought to explore Iran's economy beyond its energy sector. Just as the positive impact of non-oil exports on economic growth in Iran may now be emerging, so to is the research seeking to understand this impact. Drawing on data for the period of 1959 to 2003, Mahdavi and Fatemi (2007) conclude that that non-oil exports have a

weak impact on GDP growth due to the small share of non-oil exports relative to GDP and the high proportion of low-value goods in those exports, such as agricultural products.[5] However, the composition of Iran's non-oil exports has changed considerably in the last 15 years. Using slightly more recent data running from the period from 1970 to 2008, Hosseini and Tang (2014) find that "exports of non-oil product, labor and capital have a positive effect on economic growth," while exports of oil products "have an inverse effect on economic growth in Iran."[6] Jafari et al. (2014) find a significant and positive impact of an increase in non-oil exports on economic growth in the period of Iran's Fifth Development Plan (2010-2015), which corresponds to the peak of the sanctions period. The authors conclude that a 6% increase in non-oil exports can be associated with a 2% increase in economic growth.[7]

More recent research has sought to explore the relationship between non-oil exports and economic resiliency in the face of sanctions. Drawing on data from 2006 to 2011, Haidar (2017) observes how a process of "export deflection" saw "(a proportion of) exporters are able to redirect (part of) their exports" away from sanctioning countries and "towards politically-friendly destinations" Haidar quantifies these effects to conclude that "two-thirds of the value of Iranian exports thought to be destroyed by export sanctions have actually been deflected to non-sanctioning countries."[8]

These findings suggest that seeking to increase non-oil exports is a sensible policy in order to sustain economic growth in Iran and that non-oil exports are relatively resilient in the face of economic sanctions due to the process of "export deflection." These insights help explain why Iran's non-oil exports grew in the period from 2008 to 2016, but they do not fully explain how that growth was achieved. As Sherafati et al. (2015) have shown, Iran's import demand is driven in large part by demand for intermediary and capital goods, which support domestic

production.[9] However, import demand remains vulnerable to decreases in oil exports and thereby foreign exchange earnings, suggesting that sanctions focused on Iran's energy sector could decrease Iran's ability to import intermediary and capital inputs and thereby reduce industrial output. In effect, even if "export deflection" provides a strategy for Iran to sustain non-oil exports, the strategy is incomplete unless paired with what can be termed "import reflection," a complimentary processes or set of processes that have been studied neither in the context of Iran, nor in the context of responses to sanctions pressures.

3. Data and Methodology

To explore "import reflection" and its role in determining the relationship between the availability of intermediate inputs—which refers hereafter to intermediary and capital inputs—and industrial output, this paper uses two primary sources of time series data. First, Iran's imports of industrial parts and machinery are examined by drawing on annual trade data available from the United Nations Conference on Trade and Development (UNCTAD). For the purposes of this study, two primary (European Union and China) and two secondary trade partners (United Arab Emirates and Turkey) are included. Second, to measure Iran's industrial productivity, this paper uses the Total Productivity Index (TPI) published by the Central Bank of Iran for the period from 2001 through 2018. This constitutes the period of analysis for this paper.

To enable a Pearson correlation analysis of the relationship between exports to industrial output, an index is created for exports to Iran from each of the four trade partners. Both the trade index and TPI are based to 2018. The Central Bank of Iran's TPI index corresponds to the Iranian calendar year, which begins in March. For the sake of simplicity, when rebasing, the Iranian calendar year 1396 (March 2018-March 2019) is rendered as 2018. In this way, the TPI

data reflects a measurement three months ahead of the declared exports for a given period. However, this helps account for the expected lag between Iran's importation of intermediate inputs and their use in a productive activity.

In order to focus on sanctions-related impacts on the availability of key intermediate inputs, this paper analyzes exports to Iran of industrial parts and machinery as captured in trade data under SITC Section 7 (SITC7).[10] This category of intermediate inputs can broadly be understood to represent manufacturing inputs, but the use of SITC 7 data also helps capture trade related impacts on non-manufacturing industrial operations that support total industrial productivity. For example, the category includes exports to Iran of generators and transport equipment, which are essential to Iran's broader industrial infrastructure including mines and power plants. Such facilities contribute to non-oil exports and play a vial role in Iran's industrial base beyond basic manufacturing.

Since the early days of Iran's industrialization, European countries have been the country's principle suppliers of industrial parts and machinery. Iranian automobiles are predominately based on French designs, the country's power plants run on German generators, and the country's confectionary is made with Italian industrial ovens.[11] However, over the last 20 years, China has emerged as Iran's largest supplier of industrial parts and machinery. This shift only reflects a global trend that has seen China become a principle supplier in the manufacturing supply chains of nearly all developing economies, but also the impact of multilateral sanctions on Iran in curtailing European trade. Despite China's ascendance as a trade partner, Chinese intermediate inputs cannot directly substitute those from Europe. For those factories that are using European machinery to produce products to a European design, there will remain a need to source intermediate inputs from Europe even if some parts-content can be sourced from China. It

is therefore illogical to assume that the expansion of Chinese exports to Iran can fully offset the fall in European exports.

Here, the role of secondary trade partners such as the UAE and Turkey becomes salient. When looking to the proportion of each trade partner's industrial exports to Iran in relation to the total exports of all four partners, EU28's share of the total has fallen from 60% in 2001 to just 31% in 2018. In the same period, China's share has risen from just 8% to 35%, having reached a peak of 45% in 2015 during the final year of the multilateral sanctions campaign. The trade share of the UAE rose from 20% in 2001 to 30% in 2018, having peaked at 42 percent in 2013. Turkey is a much smaller supplier, having maintained a share of 1 to 5% between 2001 and 2018.[12]

Chart 1 - Share of Industrial Exports to Iran
Proportion of major trade partner SITC Section 7 exports to total of four partners

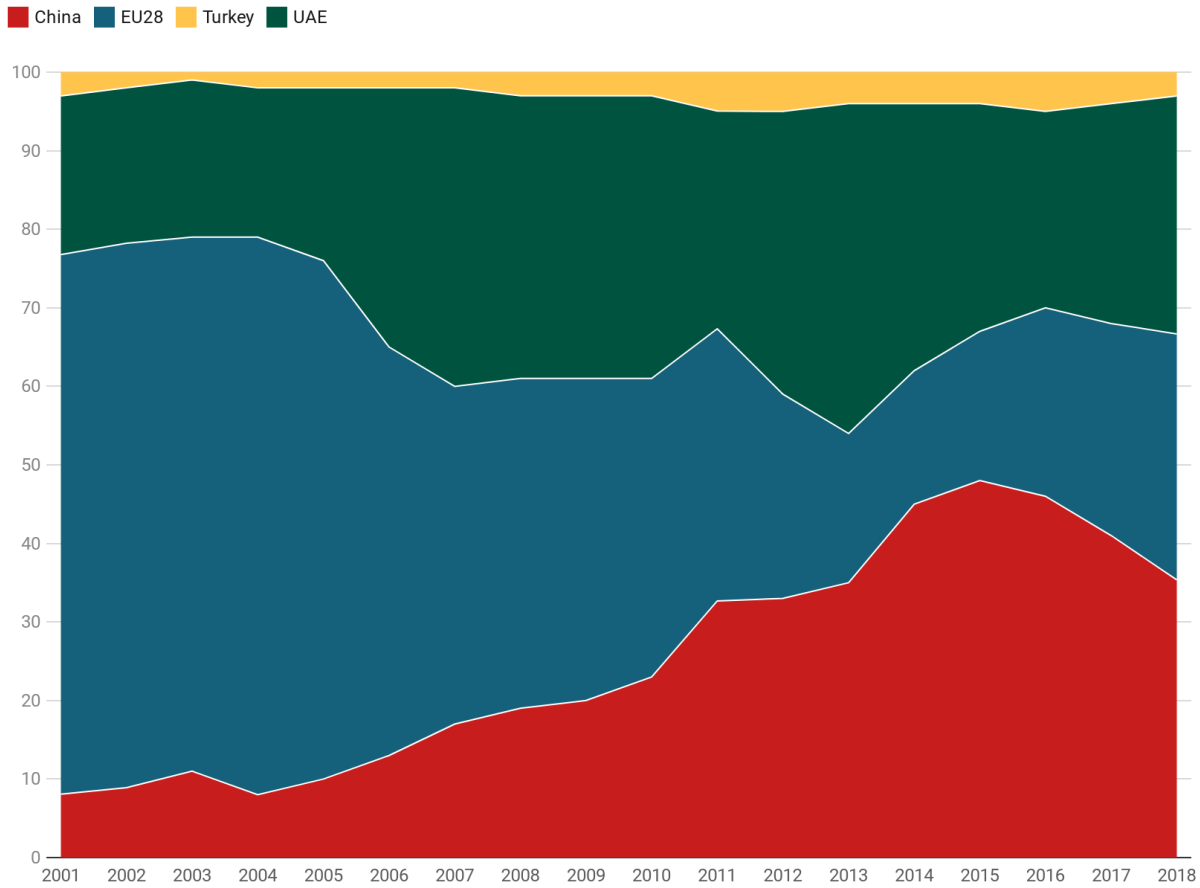
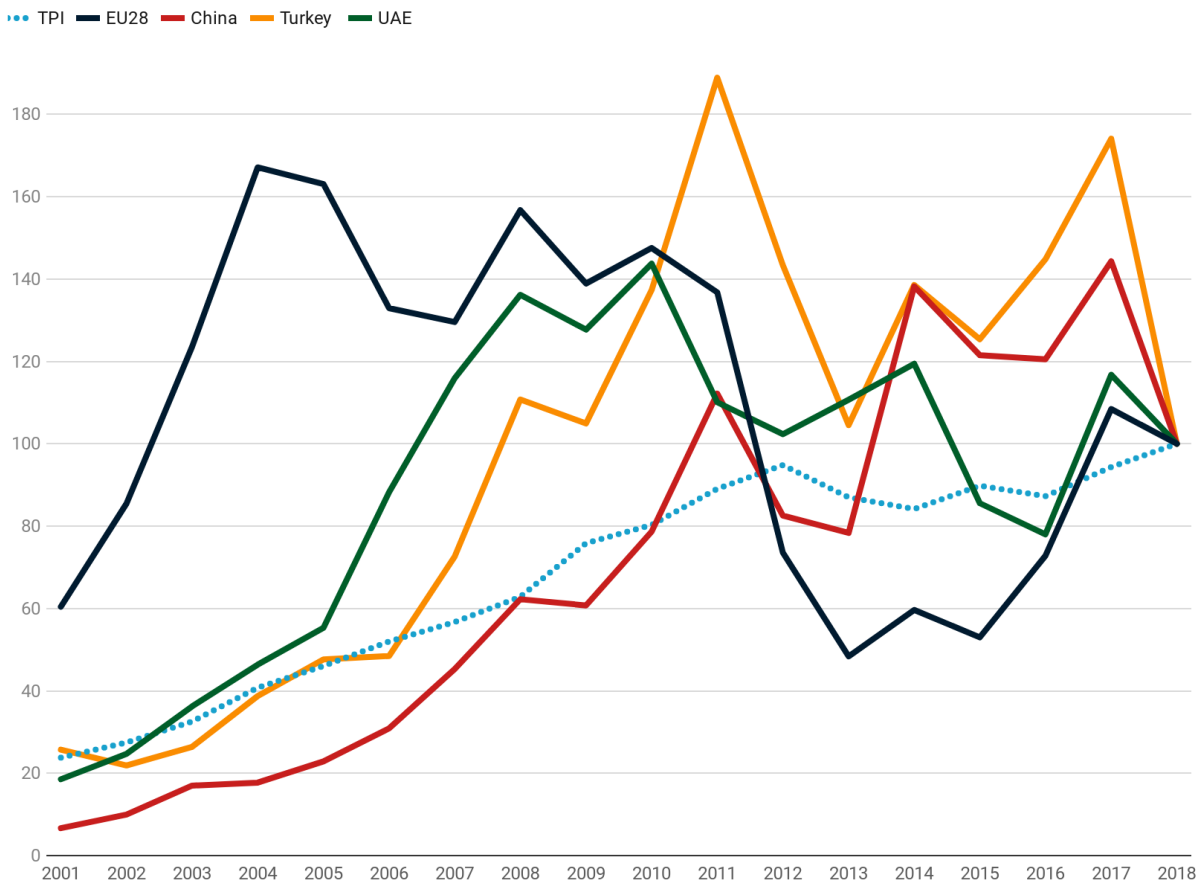


Chart 2 – Industrial Exports to Iran and Industrial Productivity
Index of SITC Section 7 exports with base year 2018



These changing proportions are indicative of two phenomena that have been widely reported in business journalism about Iran over the last decade. First, Iran is understood to have "turned East" as Western sanctions squeezed its economy. Second, Iran's economy is understood to have found some relief from sanctions through increased regional trade, which included not just export deflection, but also a greater reliance on re-export of European goods via the UAE and Turkey. But there has been little quantitative analysis to examine the extent to which expanded exports from China and a reliance on re-exports from regional trade partners like the UAE and Turkey may have contributed to Iran's industrial resiliency.

4. Results

The central hypothesis of this paper posits that if the volume of industrial exports to Iran increases so too will industrial productivity. This relationship is tested by conducting Pearson correlation analyses for the total exports from each of the four trading partners to Iran and the Iran's Total Productivity Index (TPI). While the primary focus of this paper is industrial exports (SITC7), looking to total exports (TOTAL) helps capture the important role that non-industrial manufacturing inputs also play in Iran's total industrial output. For example, the production of food or pharmaceutical products requires the importation of goods not captured by SITC7 data. Intuitively, however, we would expect a stronger relationship to exist between the export of intermediate inputs as reflect in SITC7 data and total productivity index

Table 1

Combination	r_p	Lower	Upper	p
EU-IRI-TOTAL and TPI	-0.08	-0.53	0.40	.742
EU-IRI-SITC7 and TPI	-0.28	-0.66	0.22	.263
PRC-IRI-TOTAL and TPI	0.87	0.68	0.95	< .001
PRC-IRI-SITC7 and TPI	0.90	0.76	0.96	< .001
UAE-IRI-TOTAL and TPI	0.72	0.38	0.89	< .001
UAE-IRI-SITC7 and TPI	0.74	0.42	0.90	< .001
TUR-IRI-TOTAL and TPI	0.74	0.41	0.90	< .001
TUR-IRI-SITC7 and TPI	0.90	0.74	0.96	< .001

The confidence intervals were computed using $\alpha = 0.05$; $n = 18$

Statistically significant and strongly positive correlations are observed between Chinese, Emirati and Turkish TOTAL and SITC7 exports to Iran, suggesting that as exports—and particularly industrial exports—increase from these countries to Iran, Iran's industrial productivity (TPI) also increases. But no such correlation was observed in the case of Europe, a counterintuitive finding. In the period of analysis, Europe was the only trade partner that

formally joined the multilateral sanctions campaign and applied its own trade restrictions on Iran. It is also the trade partner with the strongest direct links to the United States and its financial system. This raises the possibility that there are specific sanctions-related pressures that may have influenced the relationship between European TOTAL and SITC7 exports and TPI. This possibility can be examined by conducting Pearson correlation analyses for four specific time periods, in order to see whether there is a change in the relationship between European TOTAL and SITC7 exports and TPI before and after the imposition of sanctions.

Table 2

Combination	r_p	Lower	Upper	p
(2001-2008) $n = 8$				
EU-IRI-TOTAL and TPI	0.87	0.43	0.98	.005
EU-IRI-SITC7 and TPI	0.71	0.01	0.94	.048
(2001-2012) $n = 12$				
EU-IRI-TOTAL and TPI	0.43	-0.20	0.80	.168
EU-IRI-SITC7-TPI	0.17	-0.44	0.68	.589
(2008-2018) $n = 11$				
EU-IRI-TOTAL and TPI	-0.58	-0.88	0.03	.062
EU-IRI-SITC7 and TPI	-0.54	-0.86	0.09	.088
(2012-2018) $n = 7$				
EU-IRI-TOTAL and TPI	0.62	-0.25	0.94	.140
EU-IRI-SITC7 and TPI	0.76	0.01	0.96	.050

The confidence intervals were computed using $\alpha = 0.05$; $n = 18$

The correlation between European SITC7 exports and TPI is positive and statistically significant when the analysis is restricted to the years 2001 to 2008, prior to the full multilateralization of the sanctions campaign. It remains weakly positive when the analysis is extended to 2012 when the strictest financial sanctions were imposed, but ceases to be statistically significant. When limiting the period of analysis from 2008 to 2018, the observed relationship is negative. Finally, when limited to the period from 2012 to 2018, the correlation

reverts to a strong positive relationship in line with that observed for the other three trade partners in the overall period of 2001 to 2018. Given that European trade with Iran stabilized in 2013 after having collapsed 45 percent since 2008, one possible explanation for the observed correlations is that there was a kind of adjustment period between 2008 and 2012 after which European exports stabilized at a level which suggests that there were a significant number of supplier relationships that were inherently resilient to sanctions pressures.

The analysis here would benefit from monthly rather than annual data in order to provide more observations for the regression and to more accurately identify when the positive relationship between European exports and Iranian industrial productivity decouples. But the results do support the interpretation that the imposition of sanctions between 2008 and 2012 was responsible for weakening of the fundamental relationship between European TOTAL and SITC7 exports and TPI. Considering that TPI remained stable in the sanctions period, these results suggest that tightening sanctions not only reduced the value of European exports to Iran, but also reduced the dependency of Iranian industrial output on the supply of parts and machinery from Europe, at least in the short-term. Put another way, TPI remained stable in a period from 2008 to 2012 where the trajectory of European exports would have predicted a decline in Iranian industrial productivity.

If European SITC7 exports are positively correlated with TPI, then how could TPI remain stable from 2012 to 2016 in the same period that European industrial exports fell to half their former levels? Part of the answer to this question can be derived from the expansion in Chinese SITC7 exports to Iran both in relative and absolute terms in the period from 2001 to 2018.

Table 3

Combination	r_p	Lower	Upper	p
(2001-2008) $n = 8$				
PRC-IRI-TOTAL and TPI	0.95	0.73	0.99	< .001
PRC-IRI-SITC7 and TPI	0.94	0.69	0.99	< .001
(2001-2012) $n = 12$				
PRC-IRI-TOTAL and TPI	0.96	0.86	0.99	< .001
PRC-IRI-SITC7-TPI	0.95	0.84	0.99	< .001
(2008-2018) $n = 11$				
PRC-IRI-TOTAL and TPI	0.47	-0.18	0.83	.146
EU-IRI-SITC7 and TPI	0.55	-0.07	0.89	.077
(2012-2018) $n = 7$				
PRC-IRI-TOTAL and TPI	-0.58	-0.93	0.31	.177
PRC-IRI-SITC7 and TPI	-0.23	-0.84	0.63	.618

The confidence intervals were computed using $\alpha = 0.05$; $n = 18$

Looking at shorter time periods before and after the imposition of sanctions, it is clear that Chinese exports to Iran are not impervious sanctions pressures. The correlation between Chinese industrial exports and Iran's industrial output remains positive when looking to the sanctions period of 2008 to 2018 but ceases to be statistically significant. Finally, when looking to the period of 2012 to 2018, the correlation remains statistically insignificant but becomes negative.

An interesting comparison can be drawn with the case of European exports. When from 2012 to 2018, the correlation of European TOTAL and SITC7 exports reverts to the expected statistically significant positive relationship, the Chinese correlation inverts to a weak and statistically insignificant negative correlation. This is an expression of volatility in the trade data. Given that Iran's industrial output was stable in the sanctions period from 2008 to 2018, any volatility in export volumes from a trade partner will weaken observed relationship between exports and industrial output. In this period, European trade exhibits less overall volatility when compared to Chinese trade. For Europe, trade was higher before sanctions, fell sharply when

sanctions were applied, then remained relatively stable at a lower base. For China, trade continued to fluctuate year to year even as the total value of SITC7 exports approached a historic high in 2017.

It is difficult to explain the volatility in Chinese industrial exports definitively, but one explanation could be the ad-hoc nature of these exports as companies shifted from European to Chinese suppliers in the later years of the multilateral sanctions campaign, this is especially likely when one considers the payment solutions that Chinese suppliers and Iranian buyers were forced to seek as financial sanctions cut most direct banking ties. Payment channels that were viable in one month could become unviable in the next and this may help explain underlying volatility in realized Chinese exports, even if exports rose considerably in the decade since 2008.

However impressive, the approximately 60 percent increase in Chinese industrial exports to Iran over the last decade is insufficient to explain how Iran maintained its industrial output under sanctions. After all, Chinese parts and machinery are not direct substitutes for European items. For Iranian factories operating European machinery, or manufacturing products based on European designs and specifications, it is impossible to replace 100 percent of European inputs with Chinese intermediate inputs. Therefore, Iran's stable industrial output strongly implies that most Iranian manufacturers dependent on European inputs were able to continue sourcing those inputs under sanctions. As we have established, European industrial exports to Iran are positively correlated with industrial output when looking to the pre-sanctions period.

Iranian manufacturers were able to acquire European parts and machinery by sourcing those parts from two key markets: the United Arab Emirates and Turkey.[13] As detailed above, the proportion of combined UAE and Turkish industrial exports grew sufficiently over the period from 2001 to 2018 to suggest that this growth may have offset the fall in European exports,

particularly during the sanctions period beginning around 2008. Anecdotally, we know that Iranian companies source European intermediate inputs from UAE and Turkey and intensified the reliance on re-export through these two countries during the sanctions period.

UAE and Turkish industrial exports are positively correlated with Iran's industrial output between 2001 and 2018. But in order to understand whether this was a case of re-export of European equipment, it is important to examine the relationship between European industrial exports to Iran and industrial exports from the UAE and Turkey. The importance of re-export to Iran's industrial resiliency can be demonstrated in two ways. First, Iran's recourse to re-export should result in an increase in demand of parts and machinery made in Europe the UAE and Turkey. Therefore, exports of industrial parts and machinery from the European Union to the UAE and Turkey should be positively correlated to the exports of such goods from the UAE and Turkey to Iran.

Table 4

Combination	r_p	Lower	Upper	p
EU-UAE-SITC7 and UAE-IRI-SITC7	0.71	0.36	0.88	< .001
EU-TUR-SITC7 and TUR-IRI-SITC7	0.76	0.46	0.91	< .001

The confidence intervals were computed using $\alpha = 0.05$; $n = 18$

In both cases, a strong and statistically significant positive correlation is observed, which is consistent with the anecdotal accounts of manufacturers turning to intermediaries and trading companies in the UAE and Turkey to European source parts and machinery. However, this positive correlation may simply reflect the forces of globalization—by this logic, the same factors that enable European companies to increase their industrial exports to the UAE and Turkey also boost exports to Iran by Turkish and Emirati suppliers.

Therefore, a second relationship can be tested. If European suppliers are in fact able to export directly to Iran, we would expect lower demand for re-export the UAE and Turkey as trade intermediation typically adds costs for the Iranian importer. In this instance, European industrial exports to Iran should be negatively correlated with industrial exports from Turkey and the UAE.

Table 5

Combination	r_p	Lower	Upper	p
(2001-2018) $n = 18$				
EU-IRI-SITC7 and UAE-IRI-SITC7	0.14	-0.35	0.57	.581
EU-IRI-SITC7 and TUR-IRI-SITC7	-0.17	-0.59	0.33	.509
(2008-2018) $n = 10$				
EU-IRI-SITC7 and UAE-IRI-SITC7	0.73	0.23	0.92	.011
EU-IRI-SITC7 and TUR-IRI-SITC7	0.17	-0.48	0.70	.609

The confidence intervals were computed using $\alpha = 0.05$

Here, Pearson correlations show no statistically significant relationship between European SITC7 exports to Iran and exports from the UAE and Turkey in the period from 2001 to 2018. However, when the period of analysis is limited from 2008 to 2018, European SITC7 exports to Iran enjoy a strong and statistically significant positive relationship with the volume of SITC7 exports to Iran from the UAE. This counterintuitive finding may be explained by the fact that any improvement in the ability of European suppliers to export to Iran would probably be associated with a similar improvement in the ability of traders in other countries to export to Iran. Importantly, sanctions pressures are not the only reason why Iranian importers seek to supply parts and machinery from the UAE and Turkey. These markets offer Iranian importers an easier foreign exchange regime and a greater range of correspondent banking relationships. Crucially, many European exporters to Iran in the sanctions period turned to Emirati banks and financial intermediaries, suggesting that the openness of the UAE banking system—though now

increasingly hostile to Iran-related business—may be a covariable of both UAE and European exports to Iran.

Overall, the hypotheses tested in this paper substantiate the idea that volume of industrial exports to Iran is positively associated with industrial output and that this relationship has proven durable in the face of sanctions because of a process of "import reflection." These findings serve to demonstrate Iran's economic resiliency given the inherent connections between industrial productivity and economic growth, particularly given that the industrial and mining sectors employ approximately 20 times more individuals than the oil sector.[14] The connection between industrial productivity and employment outcomes can be tested by analyzing the correlations between TPI and total employment index (TEI) and the industrial wage index (IWI). These two indices, published by the Central Bank of Iran, help capture the importance of industrial activity to the economic well being of ordinary Iranians. Given that we would expect greater industrial productivity to contribute to job creation and wage growth, TPI should be positively correlated with both TEI and IWI.

Table 6

Combination	r_p	Lower	Upper	p
(2001-2018) $n = 18$				
TPI and TEI	0.58	0.16	0.83	.011
TPI and IWI	0.77	0.48	0.91	< .001
(2008-2018) $n = 10$				
TPI and TEI	0.81	0.41	0.95	.002
TPI and IWI	0.71	0.20	0.92	.014

The confidence intervals were computed using $\alpha = 0.05$

As expected, the relationship between TPI and TEI is positive for the period from 2001 to 2018. However, the relationship is stronger in the sanctions period from 2008 to 2018. This may

reflect the fact that Iran's employment index has been relatively stable during the period from 2001 to 2018, both because of the reluctance of state-owned enterprises to cut bloated workforces and the fact that Iranian industrialization has not yet extended to the widespread adoption of automation technologies. Likewise, the relationship between TPI and IWI is also positive, suggesting that increases in productivity do contribute to wage growth—a relationship that has been amply studied. However, this relationship weakens slightly in the period from 2008 to 2018. A spike in inflation in 2008 and persistent high inflation in the following years led to government interventions to help boost consumer purchasing power, including a 25 percent minimum wage increase enacted in 2012.[15] In this context, government policy explains why IWI increased even as TPI remained stagnant. Despite these nuances, the significance of stable industrial productivity to Iran's economic prospects is well substantiated by the demonstrable relationships with both wages and job creation.

Table 7

Combination	r_p	Lower	Upper	p
TPI and IRI-WORLD-NONOIL	0.95	0.88	0.98	< .001

The confidence intervals were computed using $\alpha = 0.05$; $n = 18$

Finally, and perhaps most importantly, there is a strong and statistically significant positive correlation between TPI and Iran's total non-oil exports to the world. Iran's manufacturing base grew in response to domestic demand—the country boasts a large consumer market of nearly 80 million individuals. However, Iranian companies have increasingly sought market opportunities abroad. Manufactured goods constitute the majority of Iran's non-oil exports, which are estimated to have earned the country around $47 billion in foreign exchange in the Iranian calendar year corresponding to March 2018 to March 2019.[16]

The Trump administration's effort drive Iran's oil exports to zero has left China as the sole customer. This means that 2019 will likely be the first year in Iran's modern history where the revenue from non-oil exports exceeds that from oil exports. The strong positive correlation between TPI and the index of Iran's non-oil exports therefore creates a direct link between industrial output and Iran's ability to earn much needed foreign exchange which can then be used to pay for imports, particularly of the intermediate inputs necessary to sustain industrial productivity. In this way, a virtuous circle is created. So long as Iran is able to sustain its imports of key intermediate inputs from trade partners such as Europe, China, the UAE, and Turkey, it can expect to grow its non-oil exports in lockstep, partially mitigating the devastating effects of sanctions on oil revenues.

5. Discussion

The relationships explored in this paper reflect rudimentary findings from the standpoint of trade economics. But when consider as contributions to the nascent study of the political economy of sanctions, they reflect an overlooked explanation for why Iran's economy was able to shrug-off multilateral sanctions between 2008 and 2016. The findings detailed here are part of the experience of Iranian policymakers and economic actors during the sanctions period and this experience explains the surprising confidence with which these stakeholders are approaching the prospect of enduring the new the new sanctions campaign initiated by the Trump administration. Put more simply, stakeholders in Tehran understand their resilience far better than the officials in Washington who intend to destroy Iran's economy and the officials in Europe who are struggling to preserve the JCPOA through economic measures.

Much of the debate around the efficacy of sanctions on Iran focuses on the impact of sanctions on Iran's energy exports, its foreign exchange earnings, and its government revenue. The analysis of this paper suggests that the focus on energy exports exaggerates the centrality of those exports to Iran's economy. The oil-centric view of Iran's economy appears to be a holdover from the 1990s when Iran's industrial base was underdeveloped and when non-oil exports constituted a marginal part of Iran's foreign exchange revenue.

However, the focus on oil exports does not mean that those emplacing sanctions do not intend to harm Iranian industry. It seems unlikely, particularly in the context of the Trump administration's maximum pressure campaign, that those policymakers responsible for targeting Iran's economy with sanctions are not considering the industrialized nature of the economy and its inherent reliance on industrial supply chains. After all, US primary and secondary sanctions go to great lengths to place restrictions on key industrial sectors including the petrochemical, metals, and automotive sectors while also targeting many of Iran's largest state-owned industrial firms as so-called Specially Designated Nationals (SDNs).

The absence of a more direct reckoning with the industrialized nature of Iran's economy likely has two causes. First, the historical conception of Iran's economy as being oil-dependent has likely resulted in a limited study of how a sanctions campaign that intends to damage Iran's energy sector and its industrial base ought to be designed. The current approach of broad sectoral sanctions and specific company-level designations is a crude one, as it does not fully account for the mechanisms by which Iran is able to deflect its imports and exports. The fact that Iran was able to sustain its industrial productivity after the imposition of severe financial sanctions in 2012 also suggests that there may be an inherent limit to how extraterritorial sanctions can reasonable impact Iran's trade relationships. In today' globalized economy, Iran can seek

substitutes for intermediate inputs from those trade partners most restricted by sanctions and deflect the imports to countries with fewer restrictions. This phenomenon of import reflection can be observed in the increase in the local production of Chinese automobiles in Iran as the traditional French industrial partners were forced to wind down their operations due to sanctions. Moreover, Iran can resort to re-export, relying on trade intermediaries to source key inputs by tapping into global supply chains, as can be seen when European industrial machinery is imported to Iran by dealers based in the UAE who may have been acquired the machinery on the second-hand market from another industrializing economy.

The second reason why targeting Iranian industry has not been a stated focus of U.S. sanctions policy stems from the political sensitivities involved in any campaign that specifically seeks to target Iran's "blue-collar" workers. Oil sanctions and financial restrictions dominate the discourse around sanctions for the simple fact that any effort to specifically stoke unemployment or reduce household purchasing power would damage the reputation of sanctions as a surgical tool of foreign policy among stakeholder groups such as the business community, journalists, and even the general public.[17] Even as the Trump administration has flirted with the suggestion that their sanctions campaign may prove sufficient to foment mass unrest in Iran, perhaps triggering a regime change scenario, there is an obvious hesitance to detail how sanctions are impacting Iran's industry. After all, it is difficult to make the case that causing the layoffs of Iranian autoworkers advances U.S. national security interests.

6. Conclusion

Assuming that those emplacing sanctions do intent to hobble Iran's industrial economy, it is significant to observe that Iran faced ultimately manageable disruptions to its tradeflow

between 2008 and 2016 and that total productivity remained stable. Further and more methodologically sophisticated studies are needed to understand the complex relationships between international sanctions, industrial productivity, and Iran's non-oil exports. In particular, the analysis of this paper should be extended to account for the important role of foreign exchange in determining both the cost of intermediate inputs and the attractiveness of Iran's non-oil exports. The pressures exerted by energy and financial sanctions on Iran's foreign exchange revenues and ability to effectively allocate foreign exchange to importers are only indirectly accounted for in the analysis presented here.

Nonetheless, the findings of this paper help explain why Iran did not experience a prolonged economic recession during the sanctions period of 2008 to 2016 despite detrimental impacts on energy exports and government revenues. As Iran finds itself targeted by U.S. secondary sanctions once again, it may be that the Trump administration's aggressive approach to enforcement will make it more difficult for Iran to sustain industrial imports and by extension non-oil exports than in the previous sanctions period. But the conclusion of Haidar's study of export deflection under sanctions is instructive. While sanctions clearly cause an "inconvenience by denying markets to many exporters, and imposing costs on others," the efficacy of sanctions campaigns is less claim "if the goal is to reduce aggregate exports." In this regard, "export sanctions may not be effective in a globalized economy in which export deflection is possible."[18] Just as the globalized economy enables the deflection of exports in the face of sanctions pressures, so too does the deflection of the industrial imports play an instrumental role in sustaining industrial productivity, aggregate exports, and economic growth, thereby underpinning the ins and outs of Iranian industrial resiliency under sanctions.

Notes

[1] "U.S. Government Fully Re-Imposes Sanctions on the Iranian Regime As Part of Unprecedented U.S. Economic Pressure Campaign," U.S. Department of the Treasury, November 5, 2018, https://home.treasury.gov/news/press-releases/sm541

[2] Nick Wadhams , Glen Carey , and Margaret Talev, "Trump to Escalate Iran Feud by Ending Waivers; Oil Prices Climb," Bloomberg, April 22, 2019, https://www.bloomberg.com/news/articles/2019-04-22/u-s-said-to-eliminate-iran-oil-waivers-after-may-2-expiration

[3] Steve Johnson, "Iran Faces Sharpest Recession Since 1980s Iraq War," *Financial Times,* August 19, 2019, https://www.ft.com/content/706bfc88-b9e5-11e9-96bd-8e884d3ea203

[4] "The Persistence of Economic Actors Regarding Industrial Output," Iran Chamber of Commerce, August 10, 2019 http://otaghiranonline.ir/news/29842

[5] Abolghasem Mahdavi and Mehdi Fatemi,"An Investigation of the Impact of Non-Oil Exports on Economic Growth–Case of Iran," *Iranian Economic Review*, vol. 12(2) 2007: 37-59.

[6] Seyed Mehrshad Parvin Hosseini and Chor Foon Tang "The Effects of Oil and Non-Oil Exports on Economic Growth: A Case Study of the Iranian Economy," *Economic Research-Ekonomska Istraživanja*, 27:1, 2014: 427-441, 10.1080/1331677X.2014.967534

[7] Somayeh Jafari, Rasul Bakhshi Dastjerdi and Reza Moosavi Mohseni. "Studying the Effects of Non-Oil Exports on Targeted Economic Growth in Iranian 5th Development Plan:A Computable General Equilibrium Approach," *Iranian Journal of Economic Studies*, 3, 1, 2014: 111-130. doi: 10.22099/ijes.2014.3114

[8] Jamal Ibrahim Haidar, "Sanctions and Export Deflection: Evidence from Iran," *Economic Policy*, Volume 32, Issue 90, April 2017: 319-355, https://doi.org/10.1093/epolic/eix002

[9] Roohollah Mohammadi and Bijan Bidabad. "Iran's Industrial Import Demand." *European Online Journal of Natural and Social Sciences: Proceedings* 4:1, 2015: 924.

[10] SITC Section 7 captures exports of machinery and transport equipment including machinery used for power generation, machinery used for industrial applications, metalworking, office machines and data processing, telecommunications equipment, electric machinery and appliances, road vehicles, and other transport equipment as well as related parts of these types of items.

[11] Jack Ewing and Stanley Reed, "European Companies Rushed to Invest in Iran. What Now?," *The New York Times*, May 9, 2018, https://www.nytimes.com/2018/05/09/business/iran-nuclear-trump-business-europe.html

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[13] Simeon Kerr, "US Sanctions Finally Bite on Dubai's Trade with Iran," *Financial Times*, March 26, 2013 https://www.ft.com/content/3a2dfd14-f762-329b-b5de-db6bee974c02

[14] "Employment by Industry Sector (1956-2011)," The Iran Social Science Data Portal, http://irandataportal.syr.edu/labor-force

[15] Alireza Ramezani, "Raise in Minimum Wage not Enough for Iranian Workers," *Al Monitor*, March 18, 2014, https://www.al-monitor.com/pulse/originals/2014/03/iran-wages-inflation-economy-law-protest.html

[16] "Iran CB Governor: $47b in Non-Oil Currency Earnings Expected for 2018-19," Financial Tribune, November 17, 2018, https://financialtribune.com/articles/business-and-markets/95138/iran-cb-governor-47b-in-non-oil-currency-earnings-expected-for

[17] There has been extensive reporting about the impact of sanctions on the wellbeing of Iranian householders. These reports make clear that despite billing of sanctions as a highly targeted tool of economic coercion, the negative consequences of sanctions are felt broadly in Iran, particularly through the increased inflation and unemployment. See: Najmeh Bozorhmehr, "Iranians Adjust to Living Under Trump's Sanctions, " *Financial Times*, May 27, 2019 https://www.ft.com/content/75a246d8-8062-11e9-9935-ad75bb96c849

[18] Haidar, "Sanctions and Export Deflection," 351.

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